

FIRST Results from Cerro Toco, Chile

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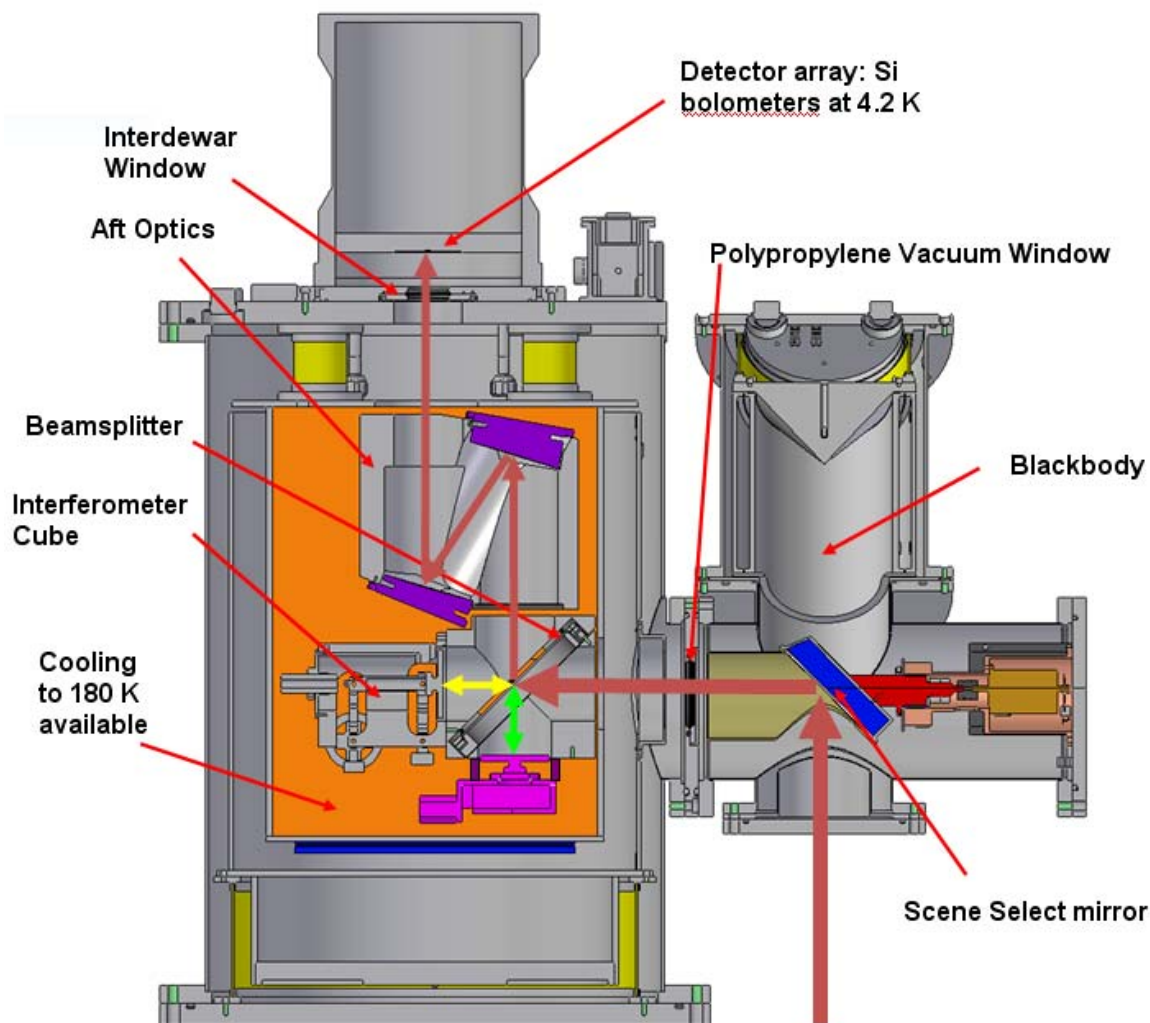
Marty Mlynczak, Dave Kratz, Rich
Cageao, Dave Johnson – NASA

Harri - SDL

Outline

- Review of FIRST project to date
 - Instrument specs
 - Timeline
 - Summary of results (mostly TMF)
- Field deployments
 - Table Mountain, CA
 - Cerro Toco, Chile
- Results from Cerro Toco
 - Comparing measurements, model calculations, and their uncertainties

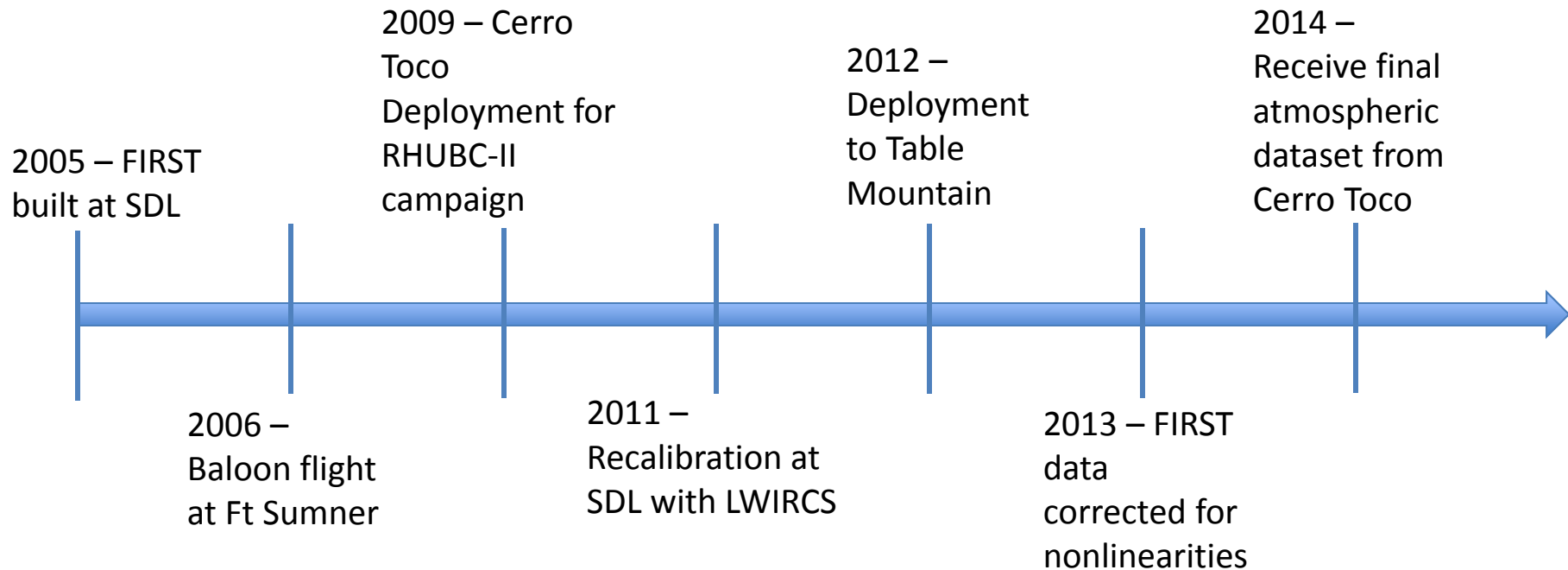
FIRST Instrument



Instrument Characteristics

- $100 - 1000 \text{ cm}^{-1}$
- 0.643 cm^{-1} resolution
- Calib. BB @ 46 C & 17 C
- 10 LHe bolometers
- Ge on polypropylene beamsplitter
- Plane mirror FTS
- 11 sec scan

Review of FIRST Project



Review of Table Mountain Campaign Results

- FIRST measurements at Table Mountain have been compared with LBLRTM calculations
- Conducted assessment of measurement and model uncertainties
 - FIRST and LBLRTM agree to within their combined uncertainties
 - The need to measure Far-IR shown as model uncertainty > measurement uncertainty
- Results from Table Mountain to be submitted to JQRST
- Moving forward with Cerro Toco analysis

Comparing the Campaigns

Table Mountain, CA

- Surface at 7500 ft
- Surface pressure approximately 775 hPa
- IPW approximately 3 mm
- Approximately 17.75 cm hot path
- Water vapor vertical profiles from radiosondes with flights of ~2 hrs

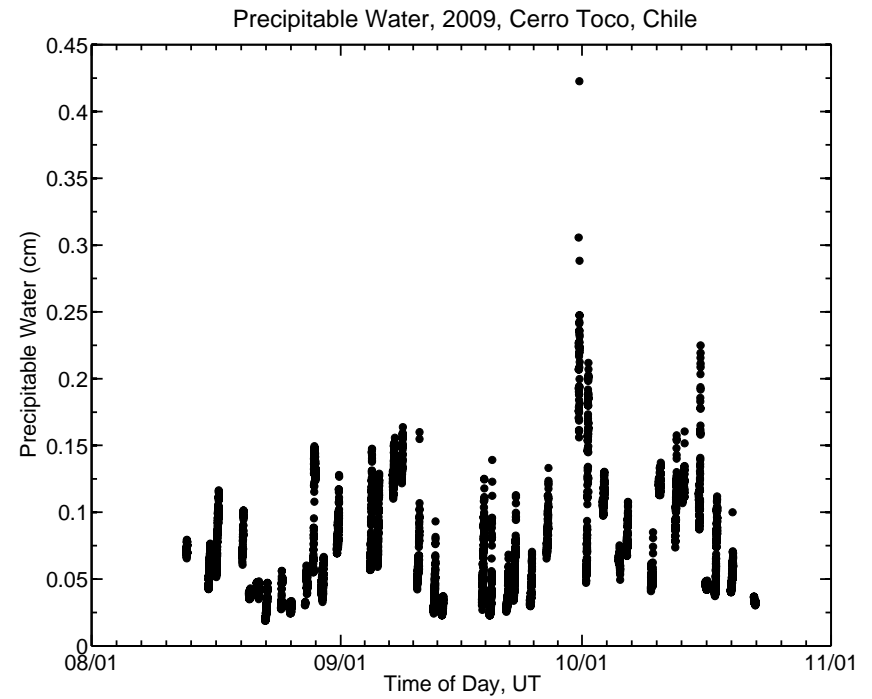
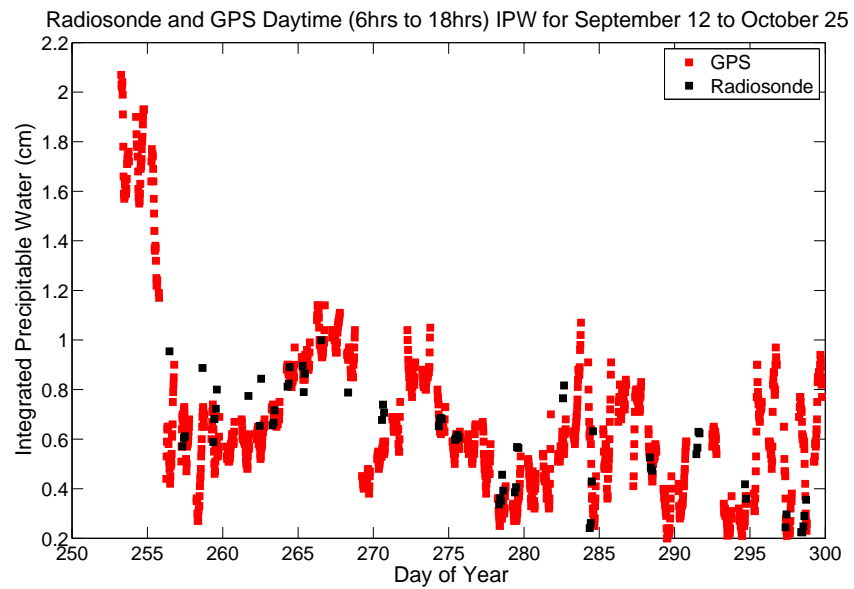
Cerro Toco, Chile

- Surface at 17,500 ft
- Surface pressure approximately 550 hPa
- Approximately 166 cm hot path
- A chimney on the FIRST trailer complicates correcting spectra for hot paths.
- Water vapor vertical profiles every ~5 minutes from GVRP
 - What exactly?

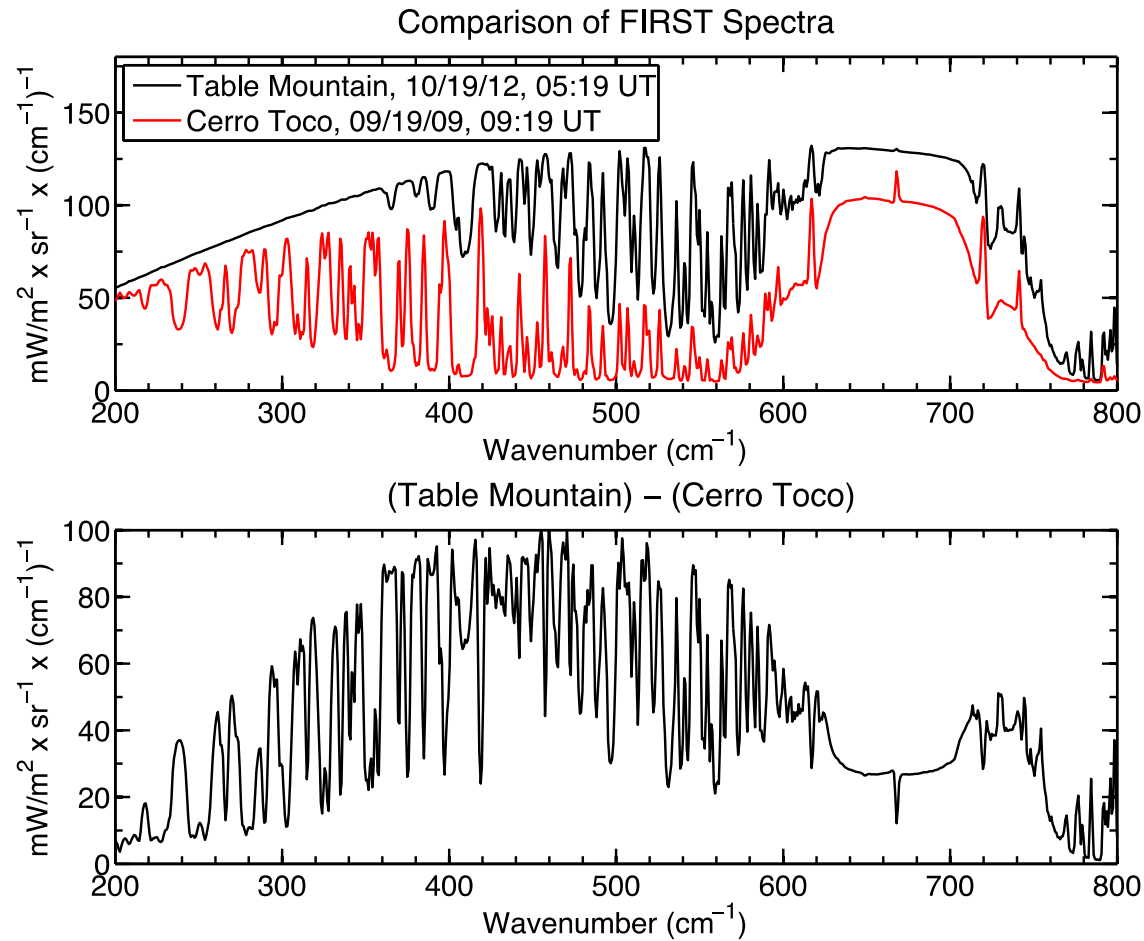
Comparing the Campaigns, cont.



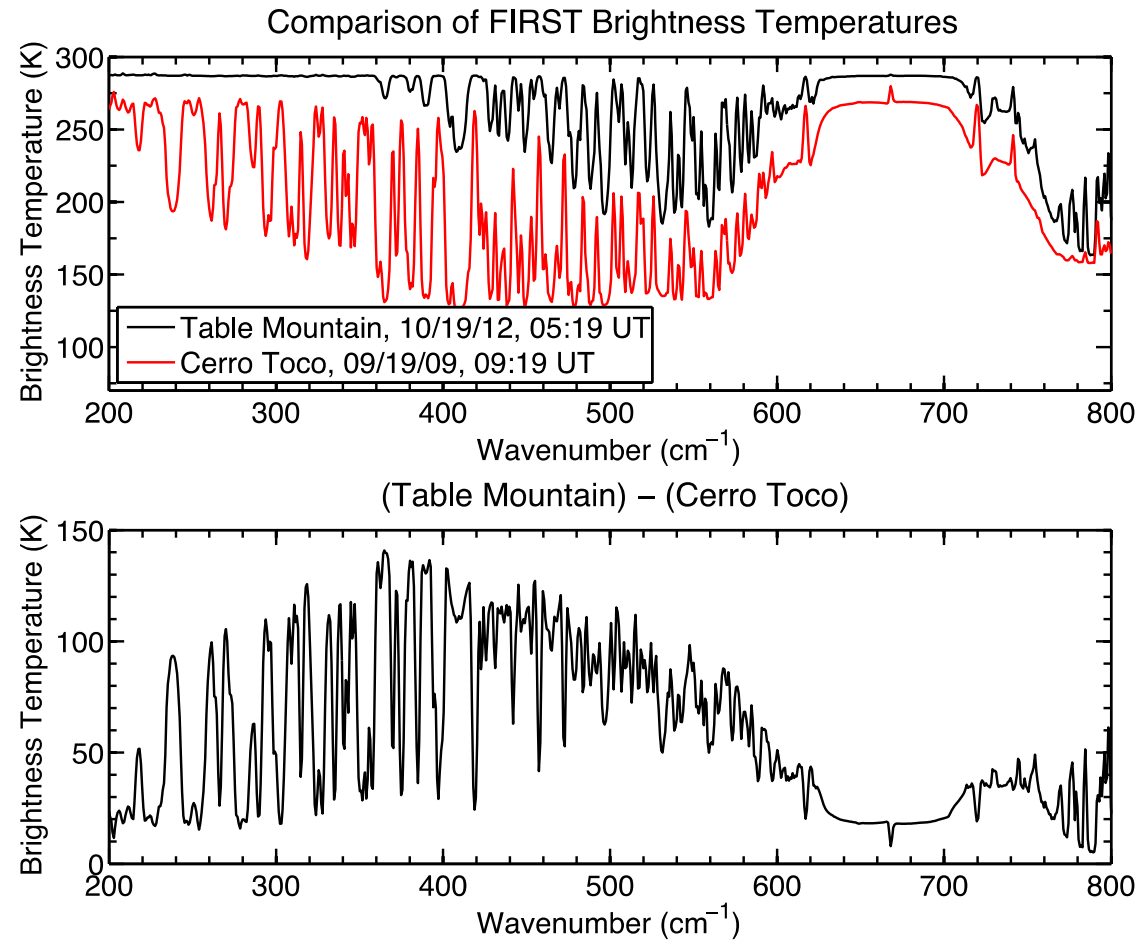
Plot both on one figure



FIRST Downwelling Radiance Spectrum



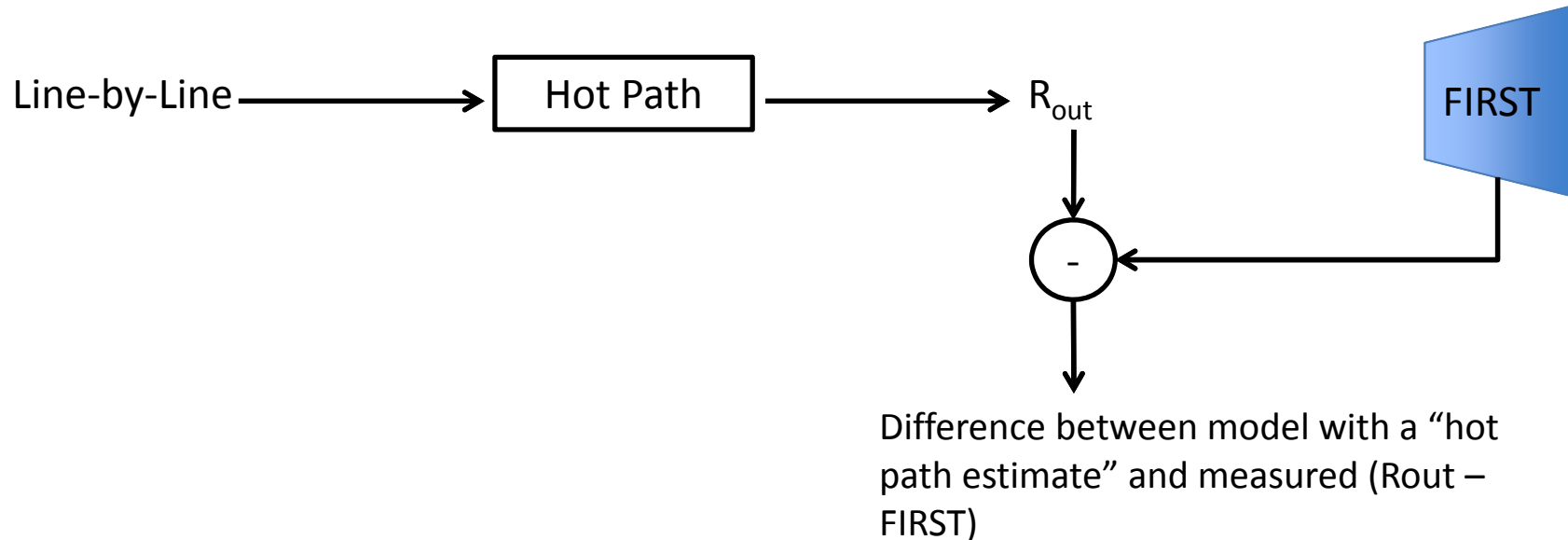
FIRST Downwelling Temperature Spectrum



Methods for Analysis of Cerro Toco

- Acquire spectra
 - Measurements from FIRST averaged in the 30 minute measurement block to reduce noise
 - Atmosphere vertical profiles placed on 71 atmospheric layers and processed through LBLRTM
 - An estimate for the hot path (hot air prior to the instrument) is included in the results subsequent to LBLRMT
- Compare modeled and measured spectra
 - Difference = LBLRTM – FIRST
- Calculate uncertainties in model radiance
 - Line strength uncertainties for water and CO₂
 - From AER v3.2 line parameter database
 - Half width uncertainties for water and CO₂
 - From AER v3.2 line parameter database
 - Water vapor and temperature measured profile uncertainty used at input to LBLRTM
 - Uncertainty in the water vapor continuum as calculated by the continuum model in LBLRTM
 - From correspondence with Eli Mlawer
- Include measurement uncertainty
 - Sky uncertainty
 - Standard deviation of the approximate 155 spectra recorded in 30 minutes
 - Uncertainty from laboratory calibration
 - From Applied Optics publication by Harri Latvikoski
- Calculated combined uncertainty
 - RSS of measurement uncertainty and model uncertainty
 - Compare measurement uncertainty and model uncertainty

Estimating the Hot Path Effect



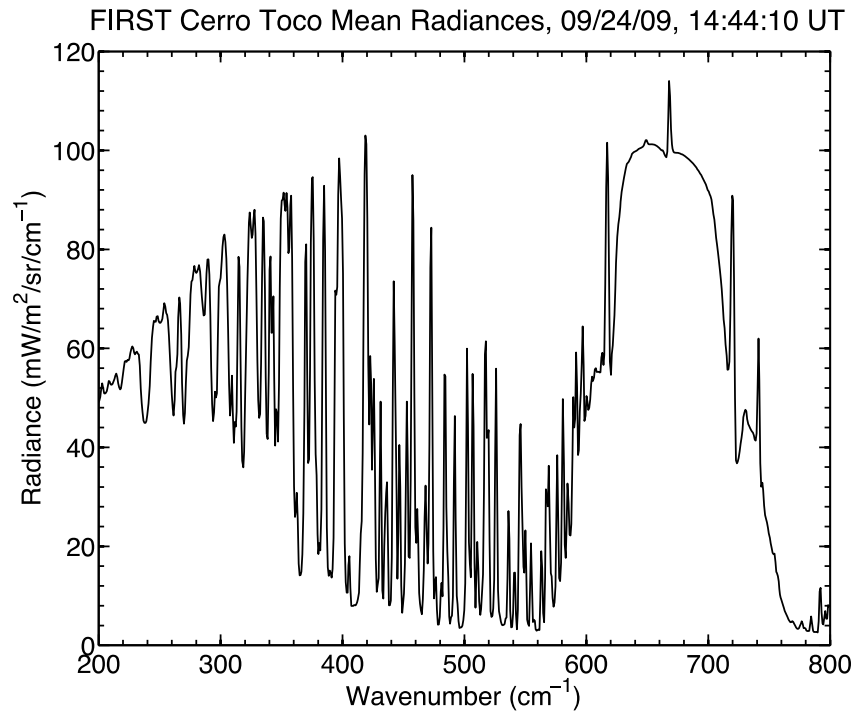
- To estimate the effect of the hot path on entering radiation

$$LBL \times (1 - \varepsilon_p) + \varepsilon_p \times B(T_p)$$

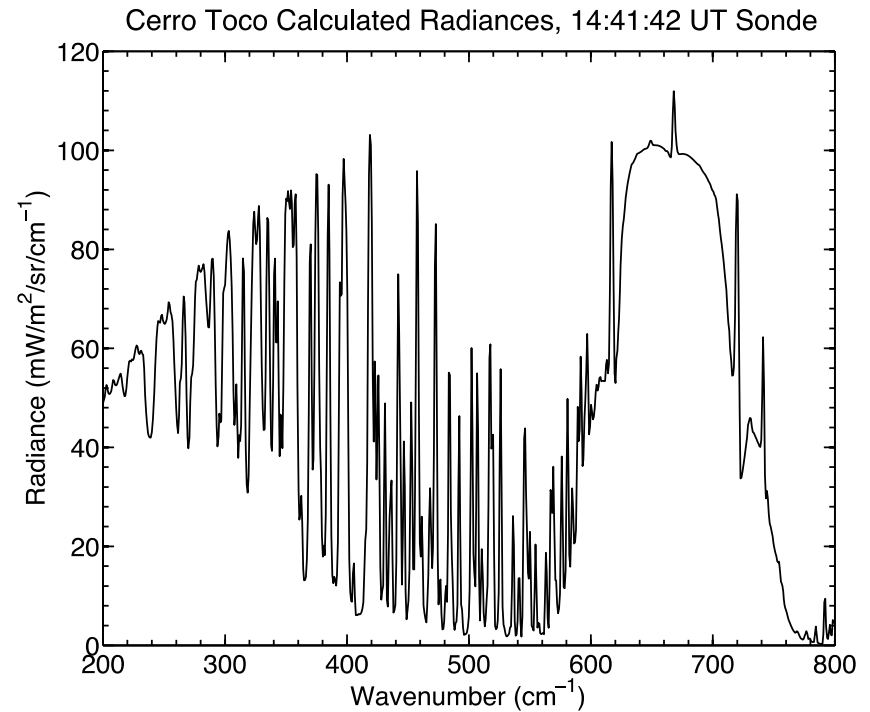
- LBL = Intensity of radiation entering the hot path
- ε_p = Emissivity of the hot path
- $(1 - \varepsilon_p)$ = Transmittance of the hot path
- T_p = Estimated temperature of the hot path
- $B(T_p)$ = Intensity of radiation emitted in the hot path

Results from 9/24/2009

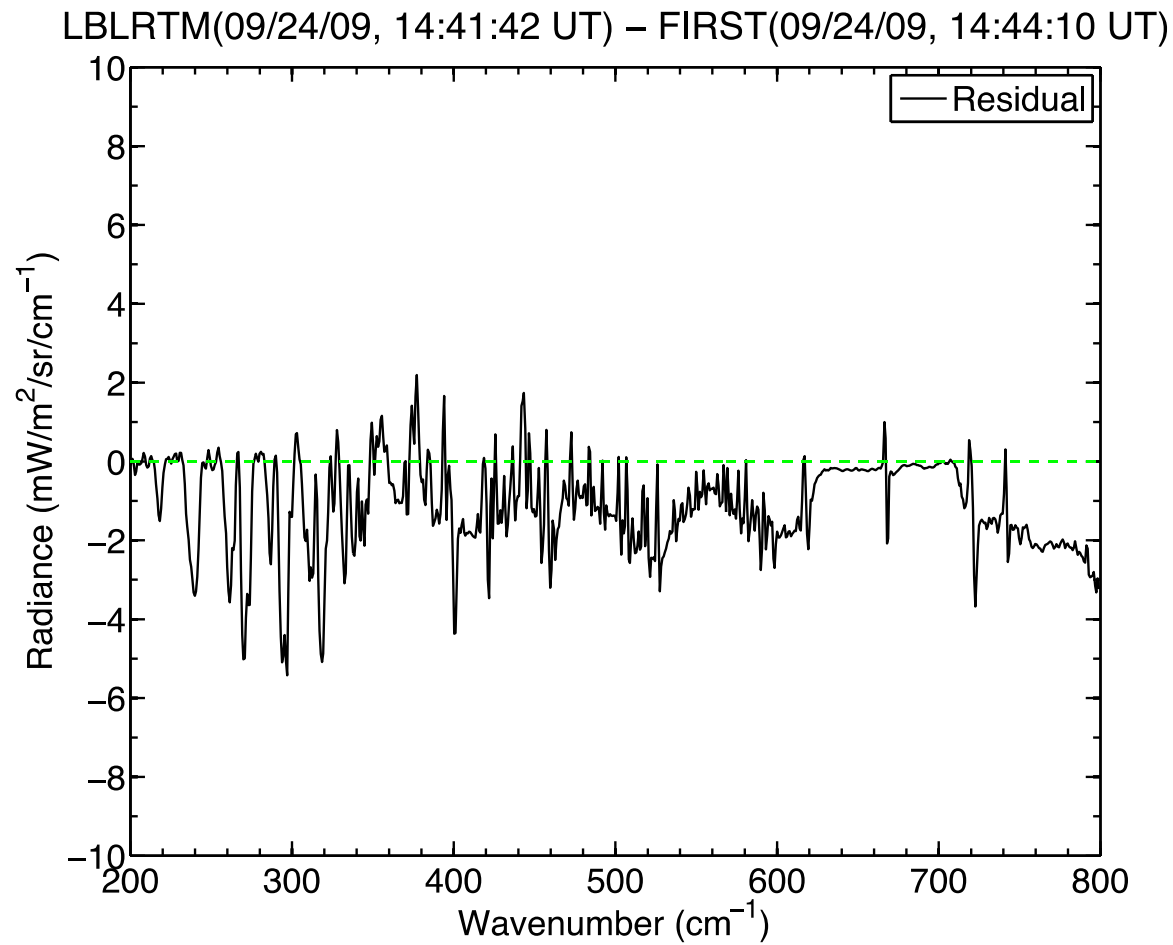
Measured



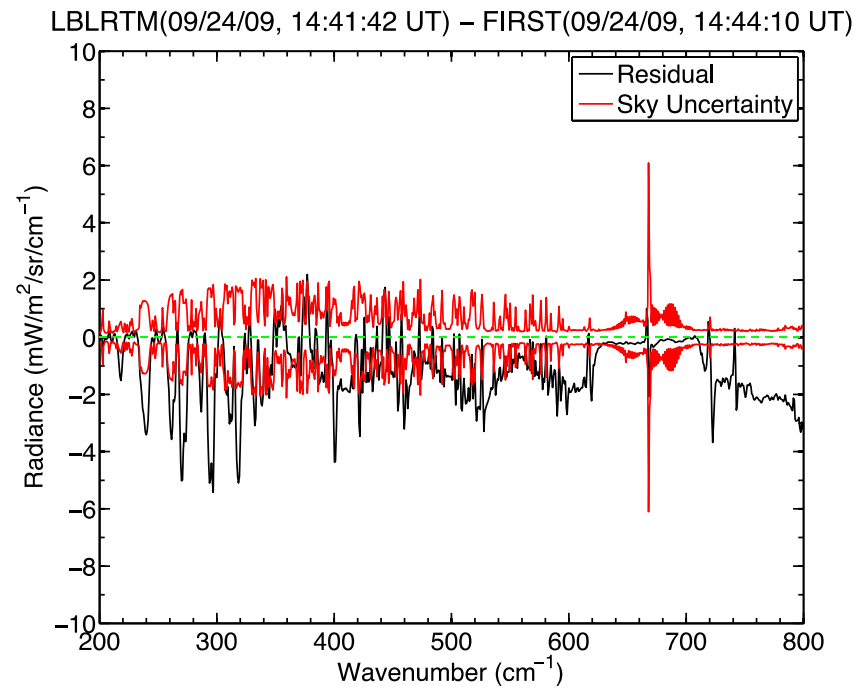
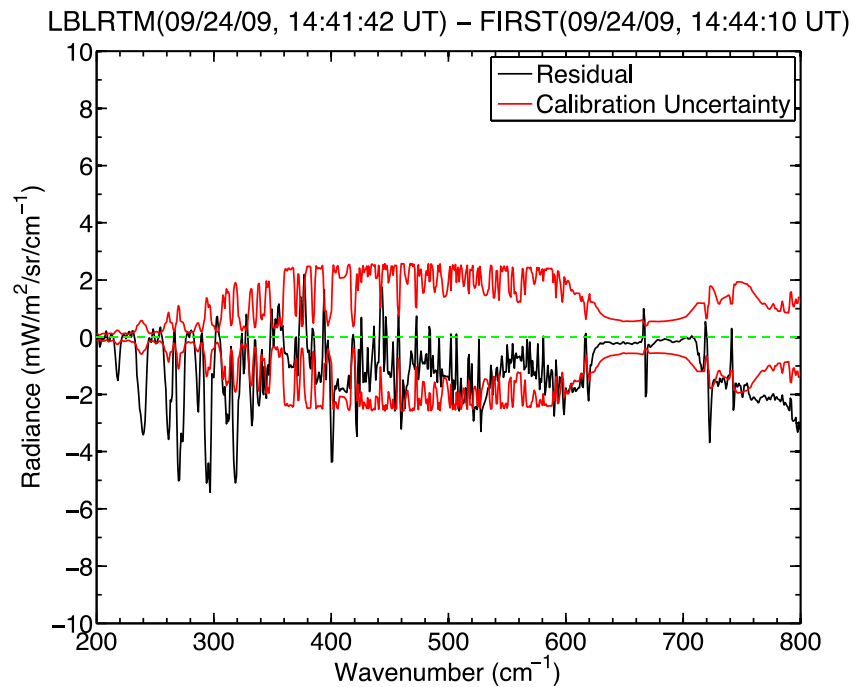
Modeled – 13K (above atmospheric surface temperature) hot path estimate included



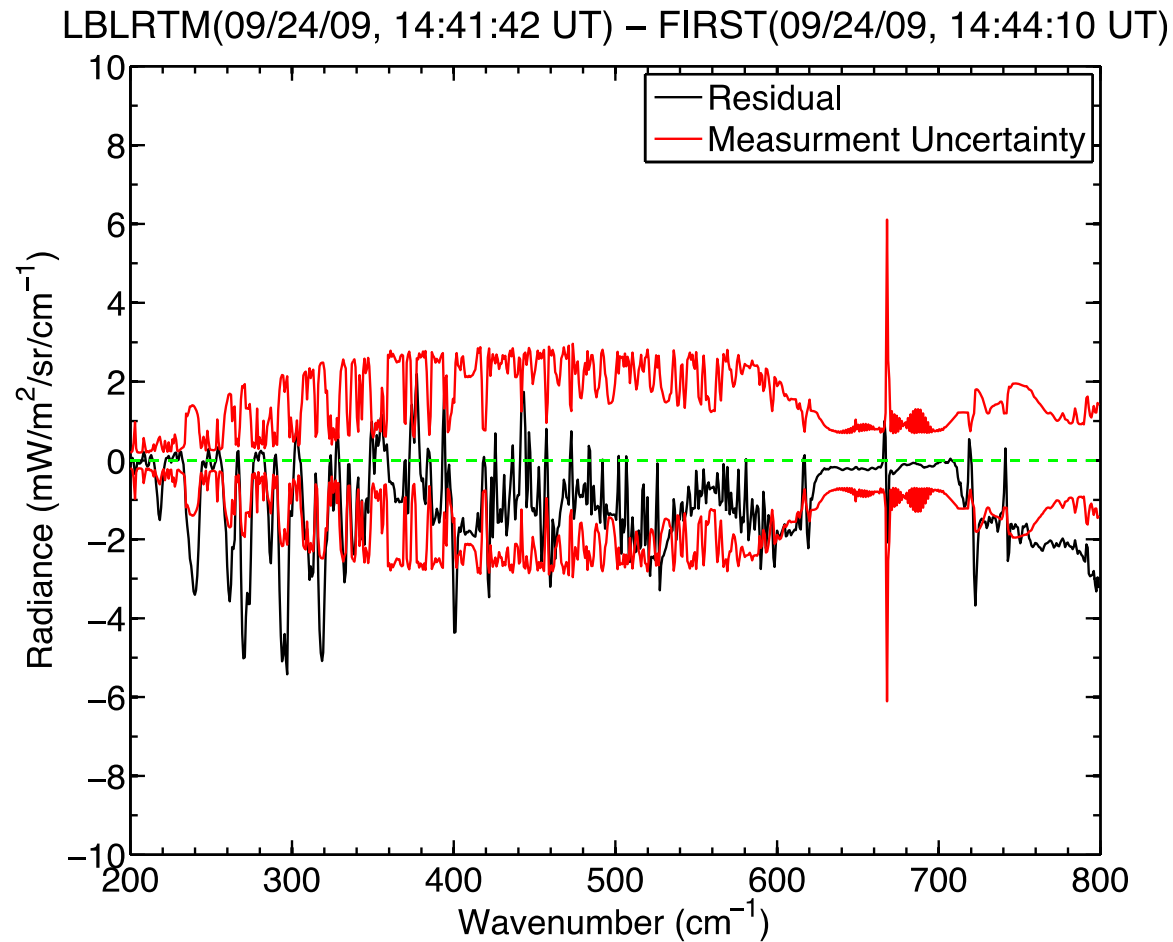
LBLRTM - FIRST



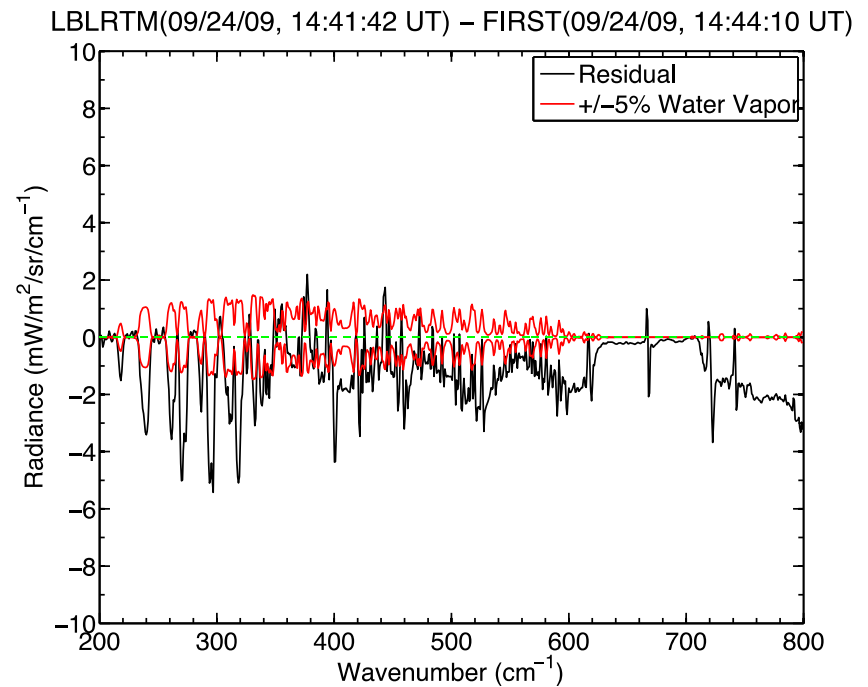
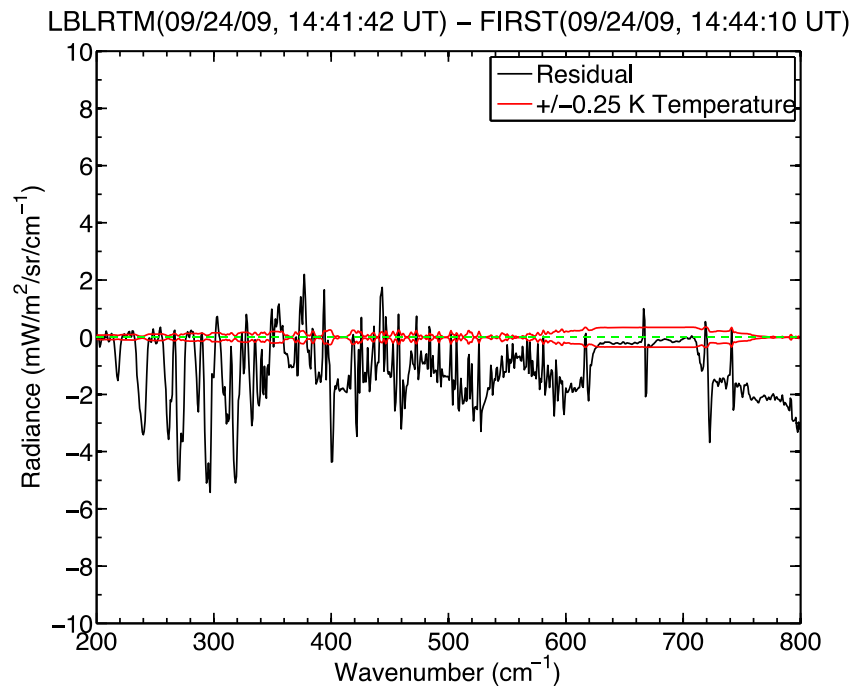
Uncertainties of Measured Spectra



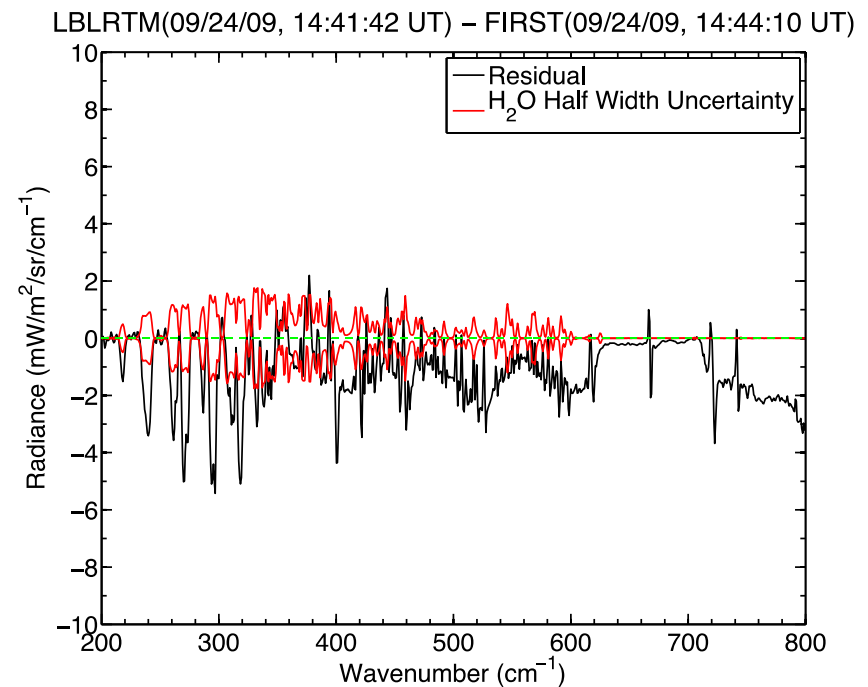
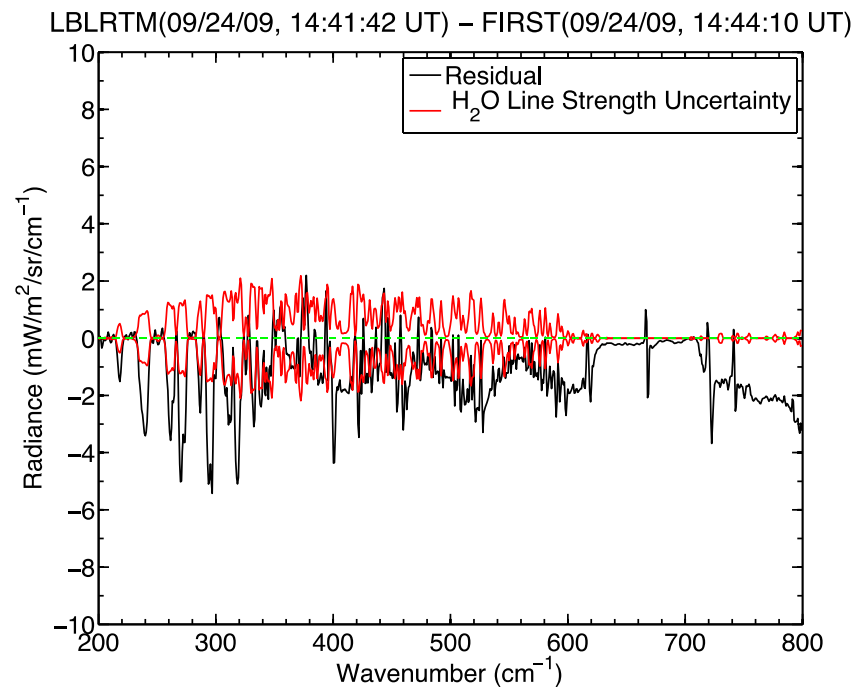
RSS of Measurement Uncertainties



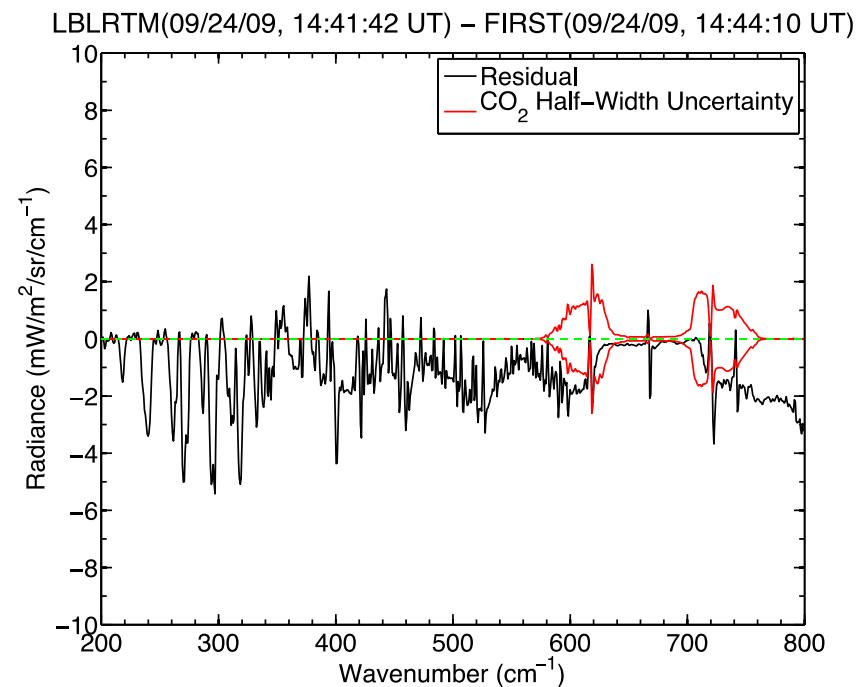
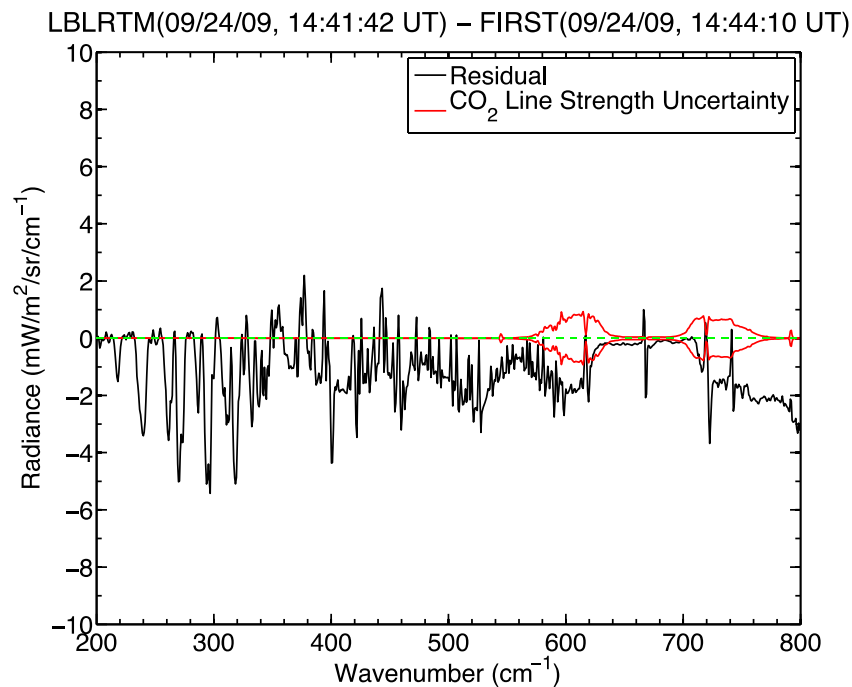
Model Uncertainties from measured atmosphere



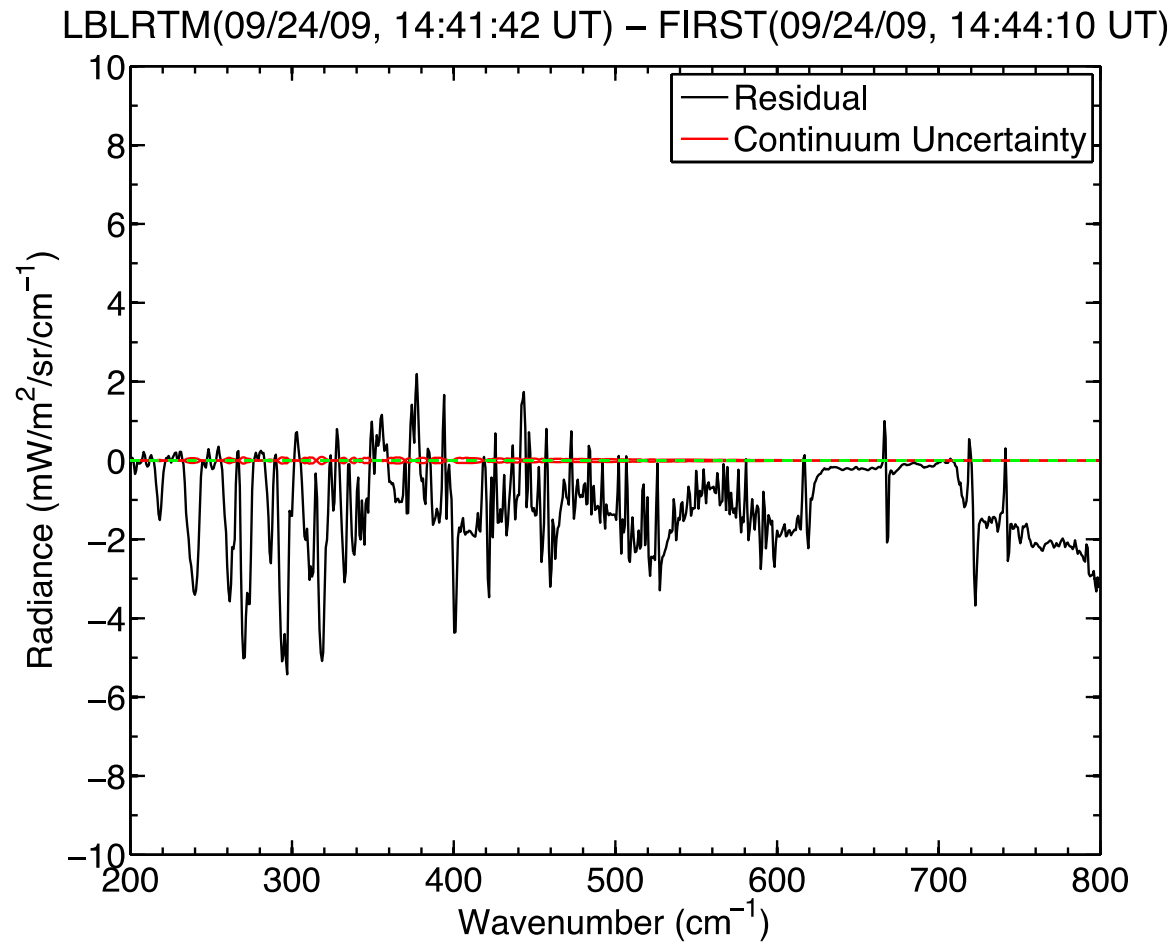
Model uncertainties from h2o line strength and half-width



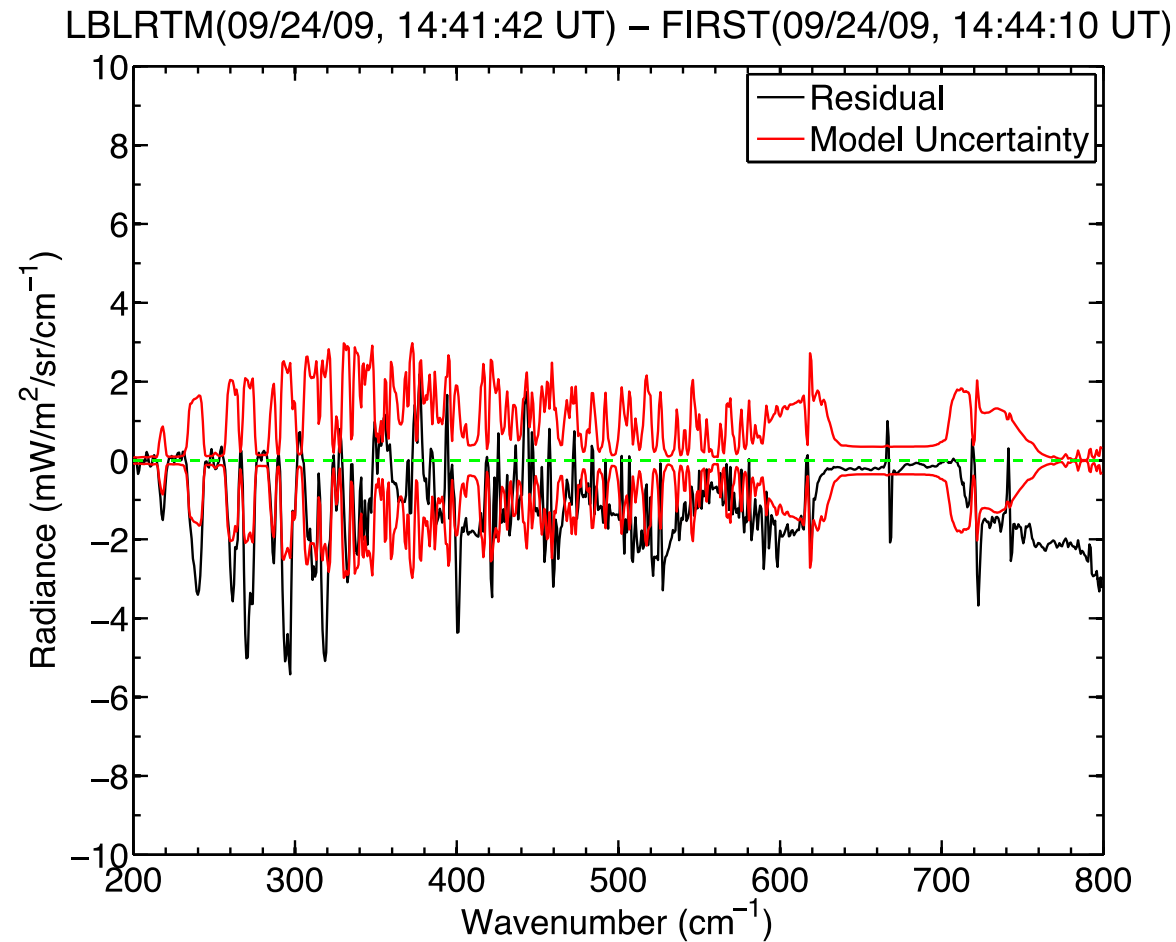
Model Uncertainties from co2 line strength and half-width



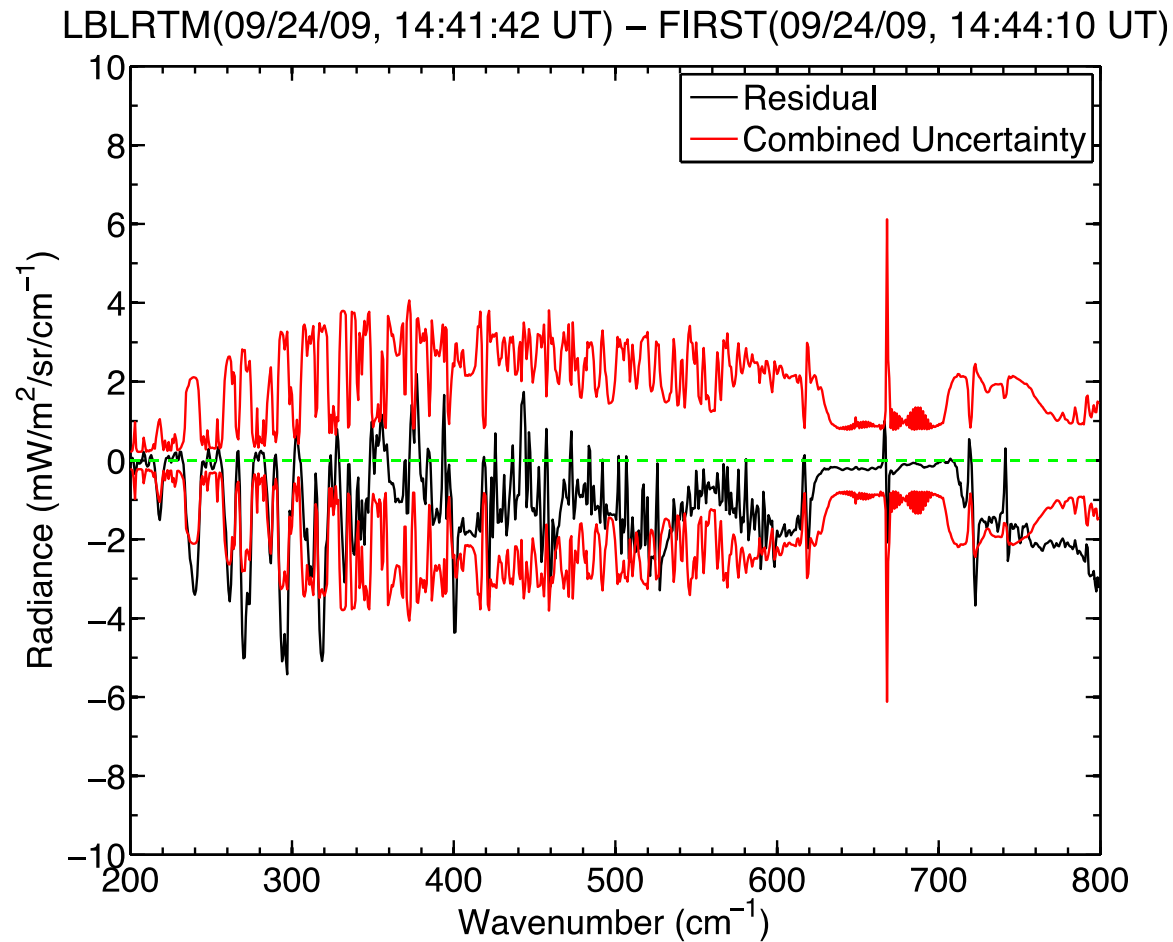
Water vapor continuum uncertainty



RSS of Model Uncertainties

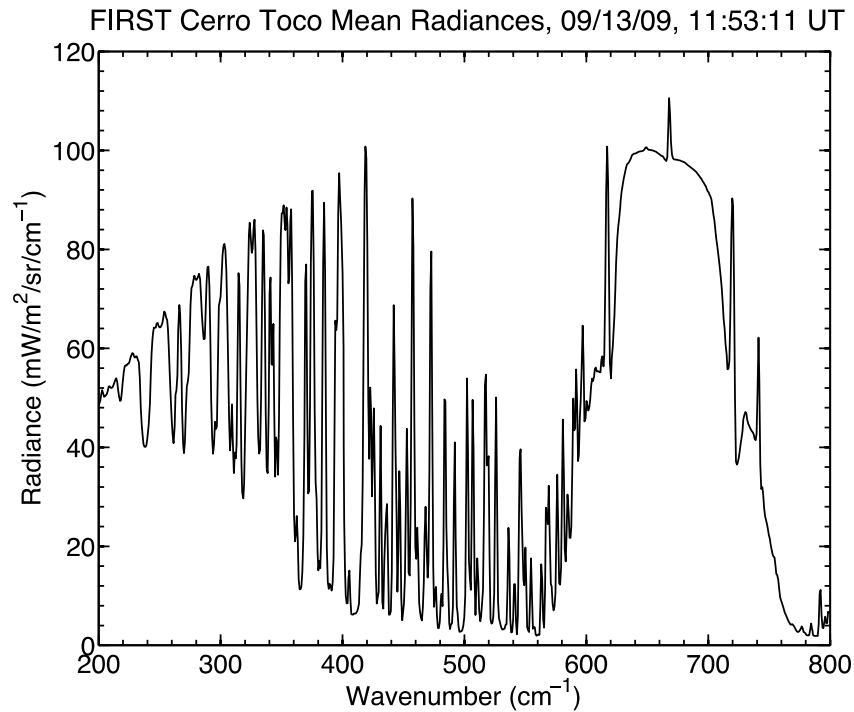


RSS of Model and Measurement = Combined Uncertainty

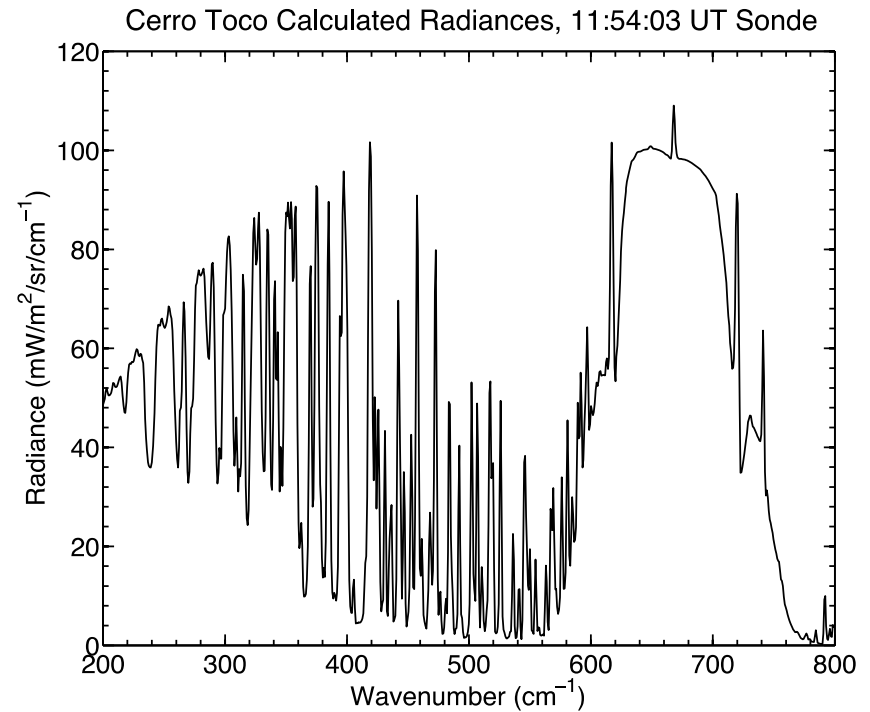


Results from 9/13/2009

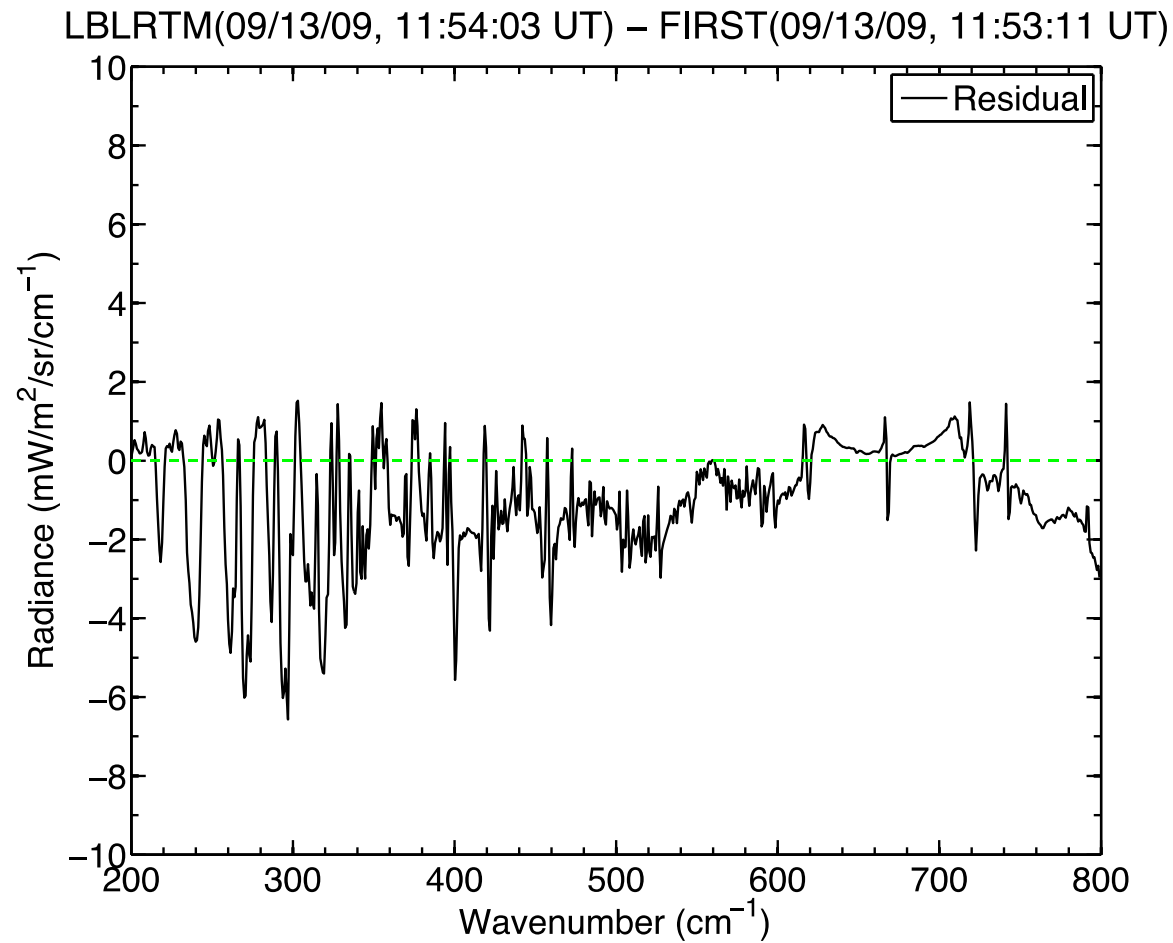
Measured



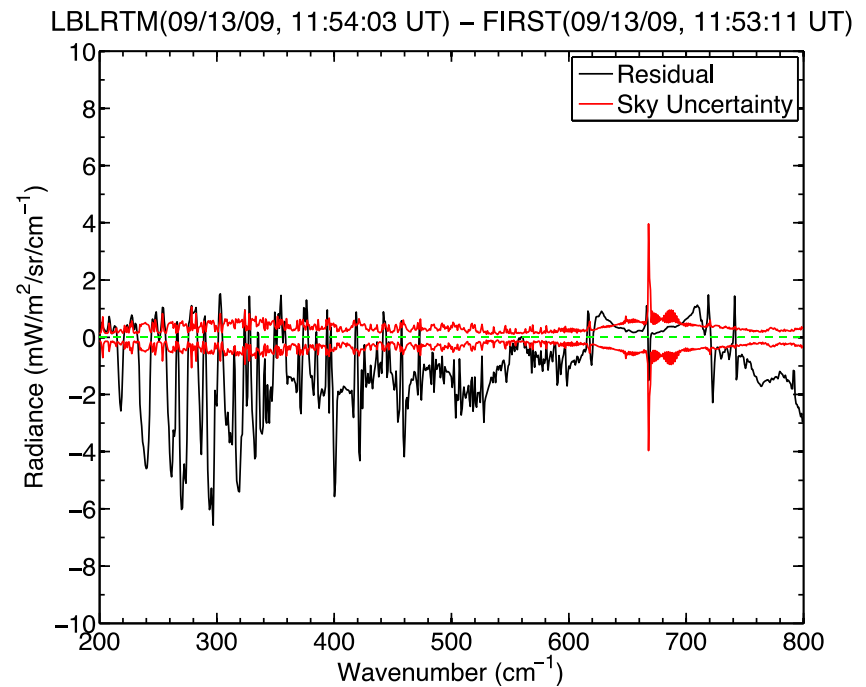
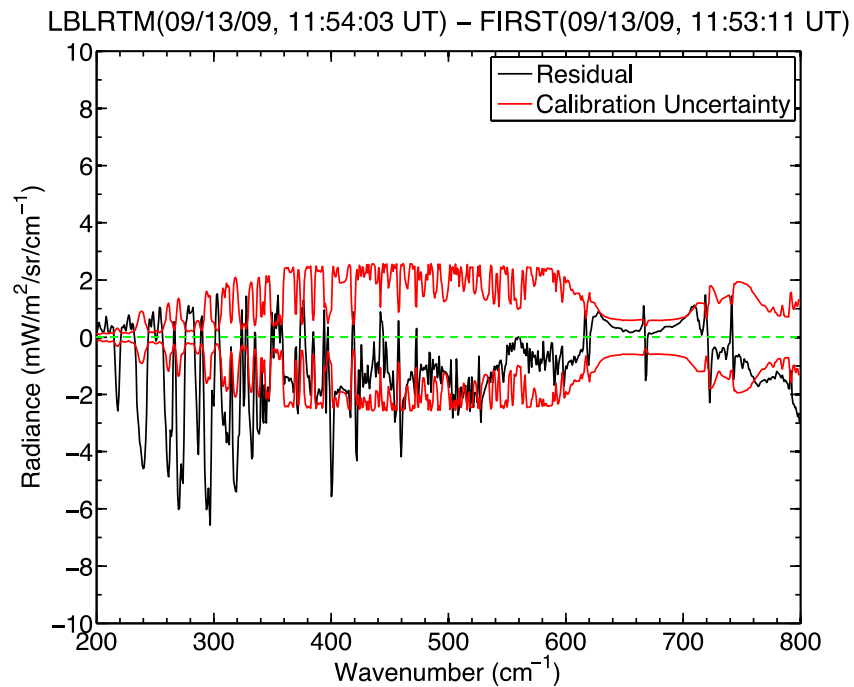
Modeled



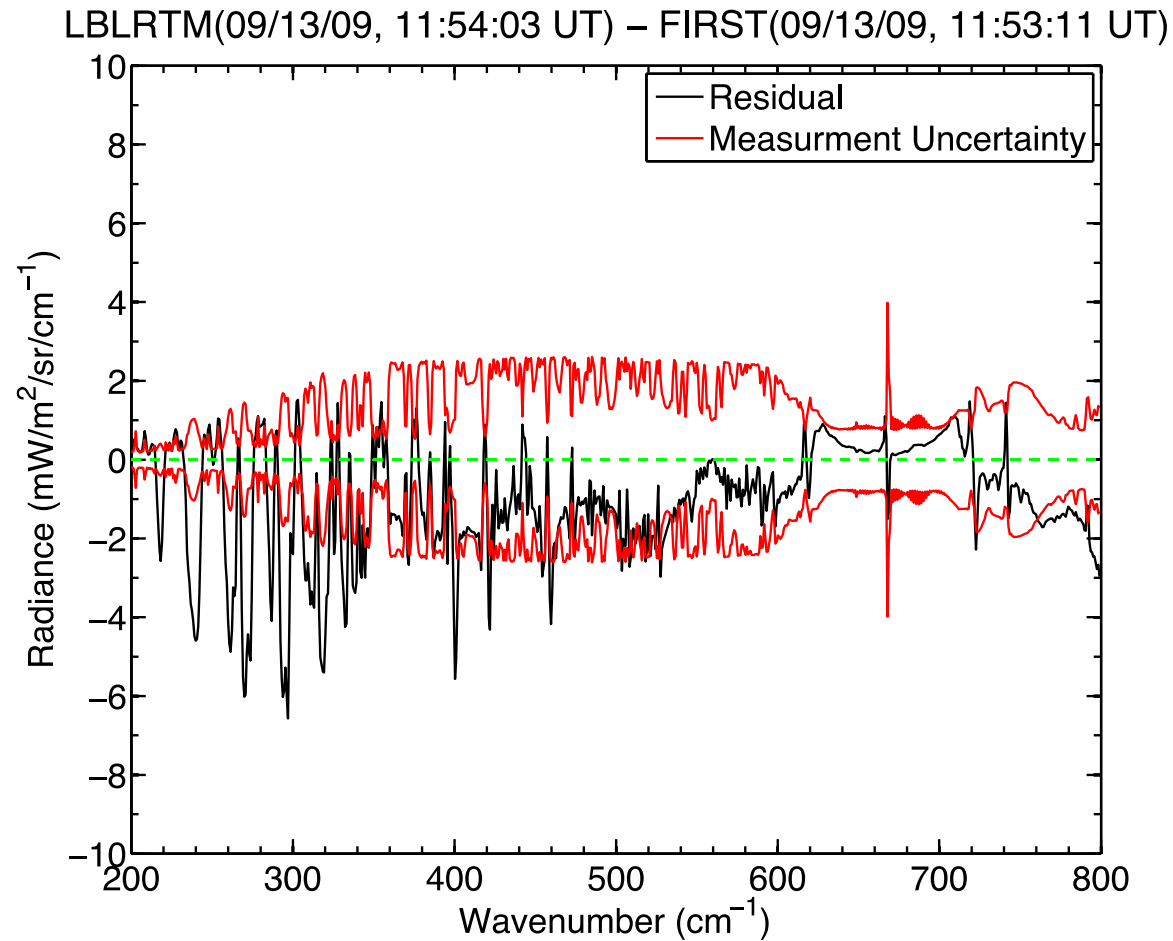
LBLRTM - FIRST



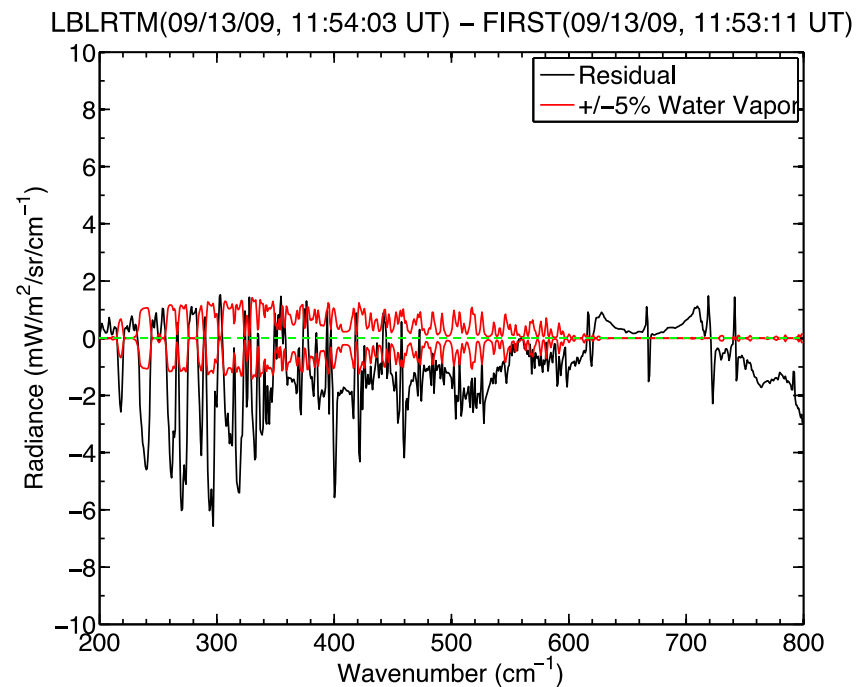
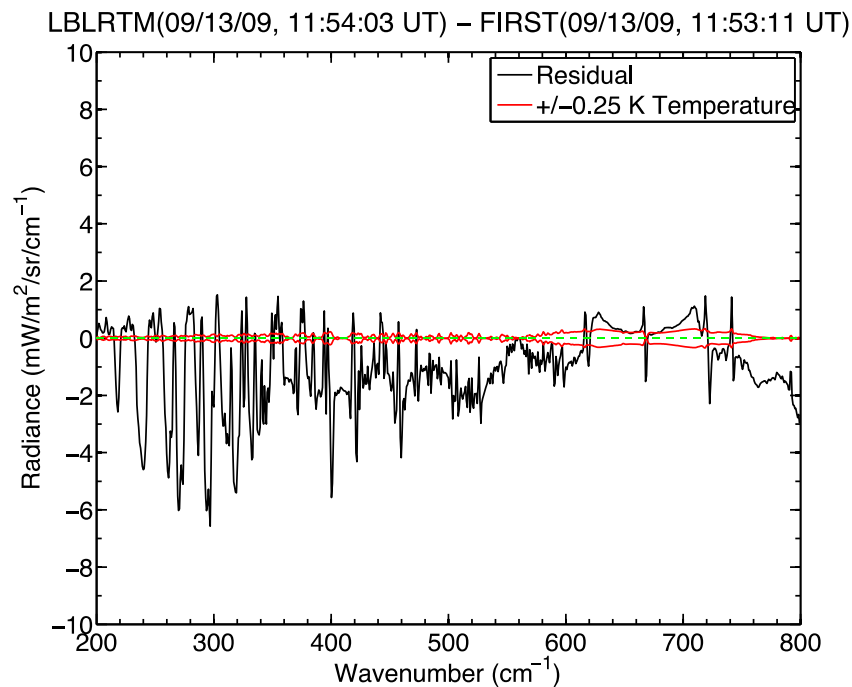
Uncertainties in Measured Spectrum



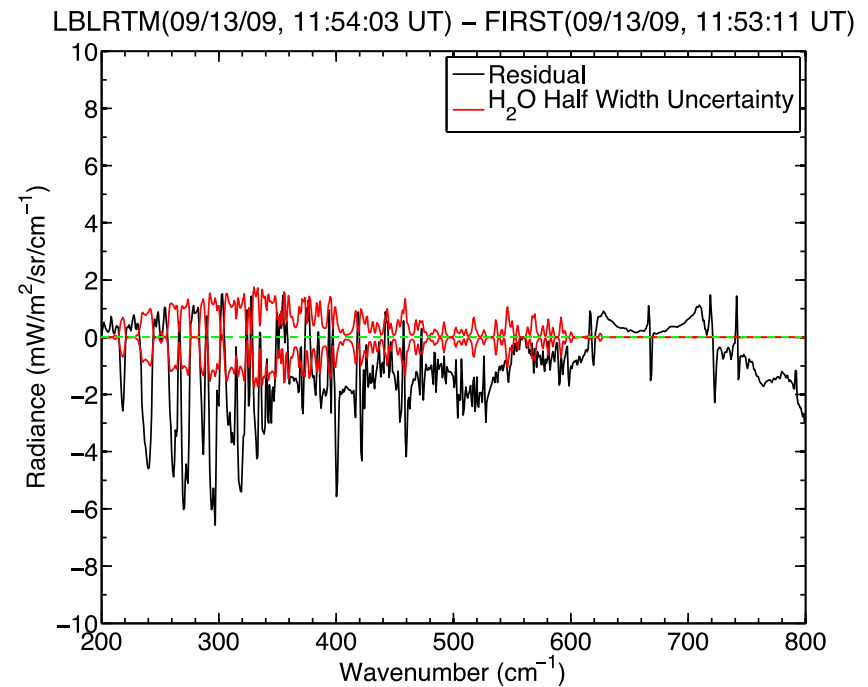
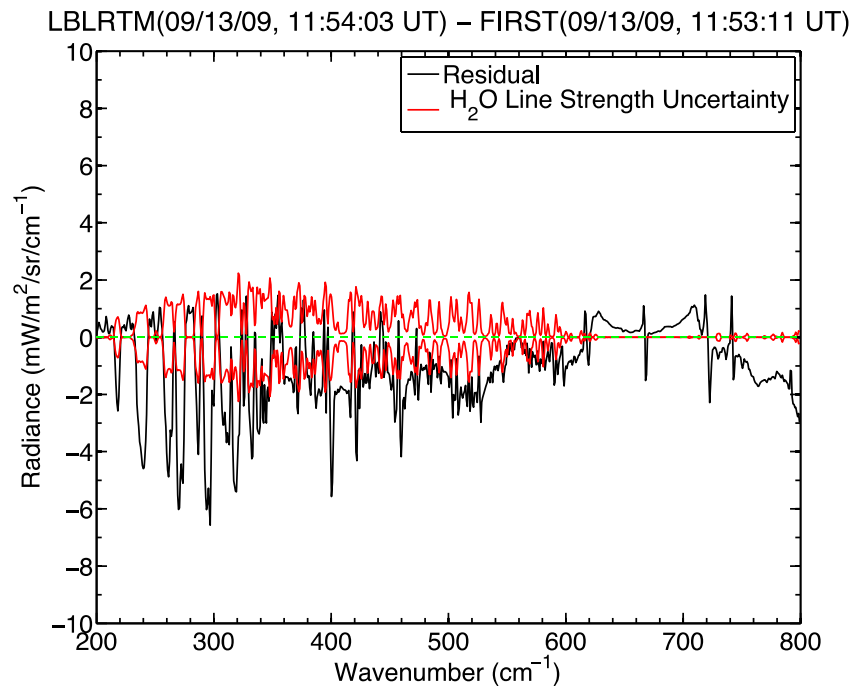
RSS of Measurement Uncertainties



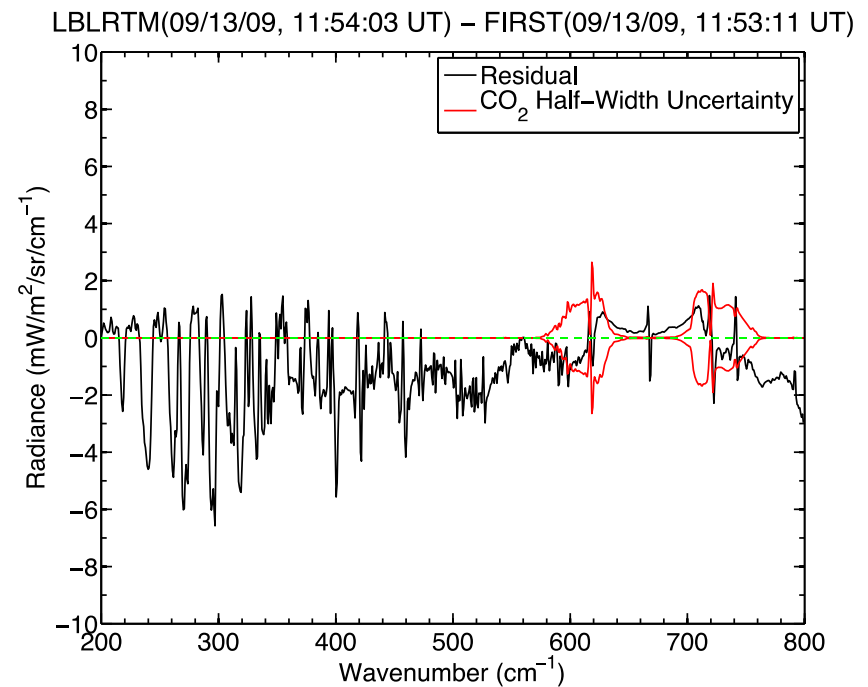
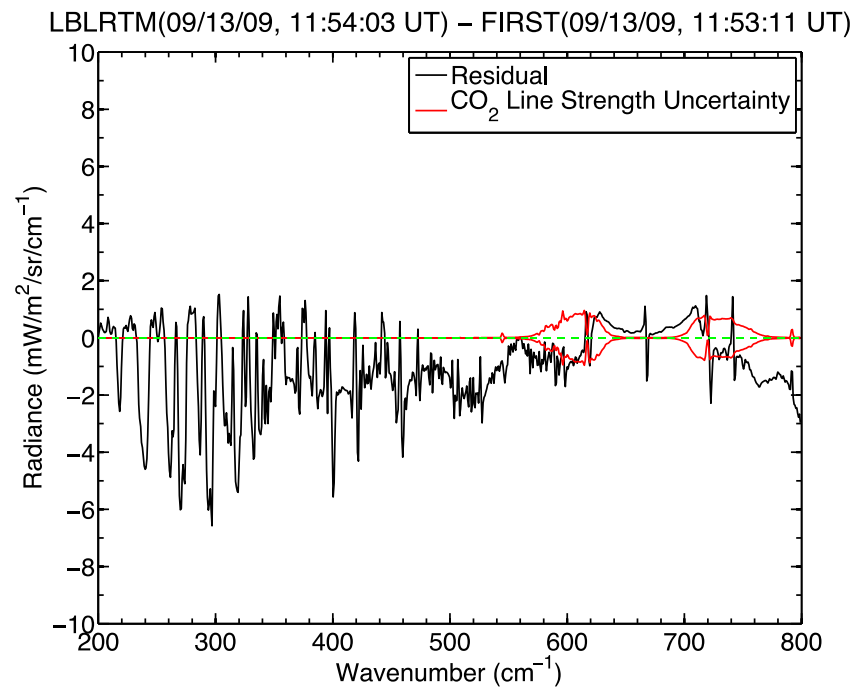
Model Uncertainties from measured atmosphere



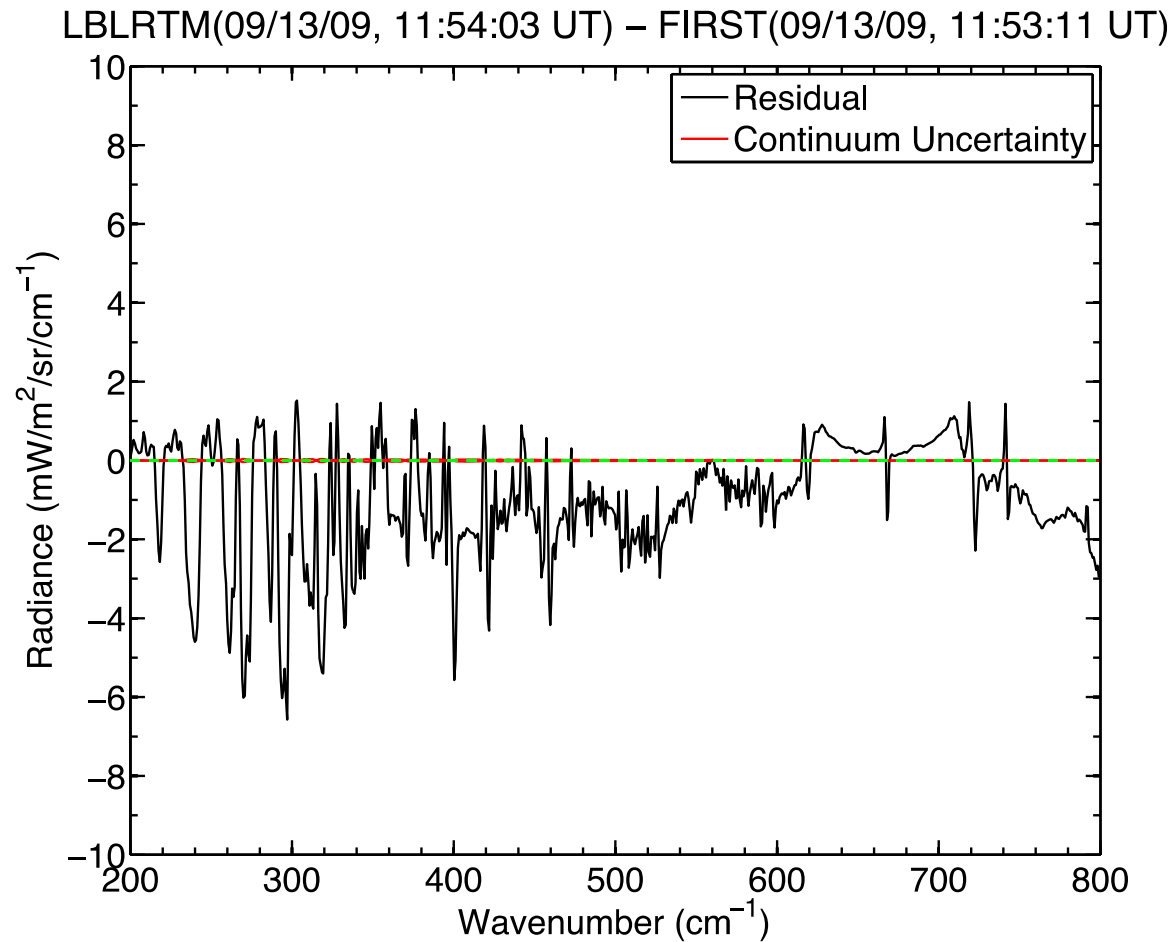
Model uncertainties from h2o line strength and half-width



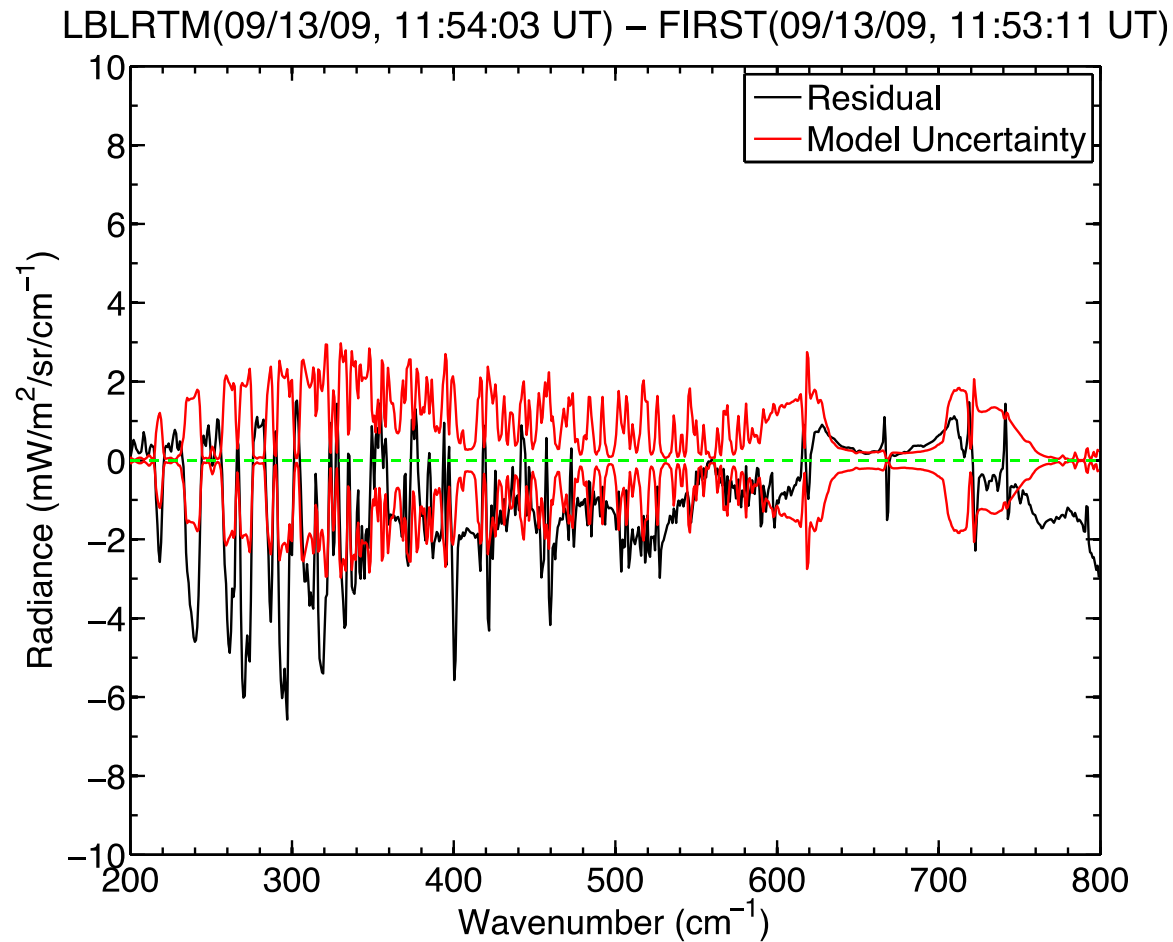
Model Uncertainties from co2 line strength and half-width



Water vapor continuum uncertainty



RSS of Model Uncertainties



Combined Uncertainty

